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CENTRIFUGE COMPRISING A SEPARATOR DISC STACK AND SEPARATOR DISC

[0001] The invention relates to a centrifuge according to the preamble of Claim 1 and to a separator disc according to the preamble of Claim 11.

[0002] Separator discs are conventionally made of high-grade steel. Particularly the achievable separation effect when separating a product, such as water or oil, into two phases deserves to be improved.

[0003] It is known to pretreat the metal surface of the standard material of the separator discs, for example, by means of an electrical or manual polishing operation. Although these measures counteract a contamination of the separator discs, they do not significantly increase the separation effect.

[0004] It is an object of the invention to increase the separation effect of the centrifuge of the above-mentioned type in a constructively simple manner when a product is separated into at least two phases, and to preferably also improve the cleaning action of the separator discs.

[0005] The invention achieves this task by means of the object of Claim 1. Accordingly, the separator discs are, at least in sections, subjected to a surface treatment changing the surface energy.

[0006] The invention also creates a separator disc for a centrifuge which, at least in sections, is subjected to a surface treatment changing the surface energy.

[0007] As a result of this measure, the separating performance or the separation effect is significantly increased or optimized in a constructively simple manner because, by means of the surface treatment changing the surface energy, the separating performance or separation effect can be adapted precisely to the respective product in that the surface

energy of the separator discs is changed in a targeted fashion such that, for example, an oil-friendly and a water-unfriendly surface occurs simultaneously. The surface treatment also increases the cleaning capacity of the separator discs.

[0008] The separator discs preferably consist of a first material which, at least in sections, is provided with at least one coating which changes the surface energy in comparison to the first material and is made of at least one other material. This measure can easily be implemented with respect to its method and offers the advantages indicated in Claim 1.

[0009] As an alternative or option, it is also advantageous for the separator discs to consist of a material into which, at least in sections, another material is diffused, which changes the surface energy in comparison to the first material; for example, by means of a method similar to surface-treating methods of the semiconductor technology, for example, by means of a plasma jet or the like. In an alternative manner, this also results in the advantages of Claim 1.

[00010] Combinations of the two above-mentioned methods are also conceivable.

[00011] The surface treatment can therefore result in chemical and/or physical bonding between the surface and the applied or inserted material.

[00012] Also for reasons of a simpler producibility, the separator discs are preferably surface-treated at the top and/or bottom side in a completely surface-energy-changing manner; that is, are, for example, provided with the coating.

[00013] It is also conceivable that different surface treatments are carried out for the adaptation to the respective phases of a material or product to be separated in the different areas of the separator discs - preferably made of high-grade steel.

[00014] In the case of a separator, each separator disc is preferably divided into several function areas in order to achieve an optimization of the value phase. In this case, the surface treatments, for example, the coating materials, preferably can be adapted to the surface energy of the light or heavy phases to be separated.

[00015] It is also conceivable to carry out different surface treatments above and below the separator discs, or radially inside and outside the separation zone, particularly radially

inside and outside a rising duct which is often arranged such that the separation zone is situated in its center.

[00016] Additional advantageous embodiments are contained in the remaining subclaims.

[00017] In the following, the invention will be explained in detail with reference to the drawing by means of an embodiment.

[00018] Figure 1a, b is a schematic representation of the method of operation of a separator disc according to the invention and a representation of the principle of the invention in comparison to the separator disc according to the state of the art on the example of a coating on the separator disc. This figures should only be understood to be strictly an example. Instead of being generated by means of coatings, the areas of other surface energy can also be generated by means of other types of surface treatment.

[00019] Figure 1 shows two conical separator discs 1, 2 of a separator disc stack 3, which is otherwise not shown here, for a separator. The separator discs 1,2 each have openings 4 which, interacting with one another, form a rising duct 5. The separator discs 1, 2 are axially spaced from one another, so that a gap 6 is formed between them.

[00020] Such a separator disc stack is shown, for example, in German Patent Document DE 36 07 526 A1 or DE-OS 19 09 996. The separator discs 1, 2 generally consist of high-grade steel.

[00021] The invention differs from the state of the art in that the upper and lower (according to Figure 1) surfaces 7, 8 of the separator discs 1,2 are provided completely or to a significant part, that is, preferably on more than 50% of their surface, with a coating 9, 10 which changes the surface energy relative to a metal disc. This coating 9, 10 may, for example, have a ceramic construction and/or may be constructed on a Teflon base and/or may be constructed as a lacquer (for example, may be silicious, silicon lacquer, or the like) and, depending on the usage, may be applied to the top and/or bottom side of the separator discs, specifically there again either completely or in sections.

[00022] As a result of the coating 9, 10 of the separator discs 1, 2, their surface can be further developed, for example, to be unfriendly with respect to water but friendly with respect to oil.

[00023] When a dispersion flows into the separator disc gap 6, the dispersion separates into the two phase of "water" on the left of the center M of the rising duct 5 and "oil" on the right of the center M of the rising duct 5. The water still contains a small residual fraction of "oil" in the form of drops which is to be removed in the separator disc stack 3. The drops of oil adhere better on the oil-friendly separator disc surface on contact than the other phase and coalesce with other drops and form an oil film. As a result of the centrifugal force, some oil moves to the side of the light phase (oil).

[00024] During the separation in the separator disc gap 6, oil drops are formed on the water side and water drops are formed on the oil side. Thus, different demands are made on the surface. The water side should be oil-friendly so that the residual oil drops coalesce better on the surface, while the oil side should have precisely the opposite characteristics. It can be derived therefrom that the separator discs 1, 2 can be divided into several function surfaces or into sections with different coatings (here, 9 and 10).

[00025] The coating 9, 10 is therefore preferably divided in different areas; that is, in the area of the lighter phase, the coating is adapted to the latter, so that mainly this lighter phase adheres to the separator discs 1, 2, while, in the area of the heavy phase, it is adapted to the heavy phase so that here this phase adheres more to the separator discs 1, 2.

[00026] In this case, it not only becomes possible to adapt the coating or the surface energy of the coating of the separator discs 1, 2 in the different areas to the different phases to be separated from one another, but it also becomes possible to adapt the surface energy to the centrifugal material to be processed, so that the coating selected, for example, for the separation of an water/oil mixture should differ from the one selected for separating other liquids.

[00027] The advantages are the thereby achievable reduction of wear as well as lower friction values and an increase of the resistance to corrosion.

[00028] An experiment has shown that a bilge water separation into oil and water - as carried out onboard a ship - can achieve a clear increase of performance.

[00029] In the left-hand drawing, Figure 1b shows the flattened shape of a wider water drop on an uncoated separator disc, and the right-hand drawing shows a corresponding water

drop on a correspondingly coated separator disc which is narrower and clearly higher but has the same volume, which is promoted by the correspondingly selected coating of the separator disc. The following should be noted here concerning the theory of coatings. In addition to the surface structure, the surface energy is a criterion for adhesions. The treatment of the separator discs by polishing changes the surface energy only slightly but does not generate a so-called non-stick layer. A reduction of adhesions can be explained by the implemented change of the structure. The surface energy of the separator discs 1, 2 is situated in an area of an adhesive layer and is water-friendly (separator; for example, water/oil).

[00030] The phenomenon of the free interfacial energy can be explained thermodynamically. For a given system, the proportional action factor between its energy and its interface is the so-called interfacial tension or, more precisely, the "free interfacial energy". In order to enlarge the interface of a system, work must be carried out. The free surface energy is additively composed of the dispersive and non-dispersive (polar) energies or interactions.

[00031] $\sigma = \sigma^P + \sigma^D$

σ^P : non-dispersive (polar fractions of interfacial energy)

dipole - dipole interaction

hydrogen bonding

Lewis acid / base interaction

charge - transfer interaction

σ^D : dispersive fraction of interfacial energy

Van der Waals interaction

[00032] Each atom or molecule has dispersive forces which are generated because of the local and temporary fluctuation of the electron sheath density. The non-dispersive (polar) forces are a plus which, because of special (for example, functional) groups, contributes to the total interaction.

[00033] If the treated solid is to be brought in contact with a liquid, which occurs during lacquering, gluing, cleaning, wetting of a liquid on a surface, etc., the surface energy of the

solid in the case of a given liquid is the wanted value for determining the surface energy. Thus, according to the invention, it is also advantageous in the area of the separator discs 1, 2 for a liquid to exactly match the corresponding parameters of the solid with respect to its surface tension, because, in the event that the energy of the solid is too low, the surface parts are wetted less.

[00034] In most cases, the adhesion can be explained directly by means of the surface energies of the two adhesion partners. For this purpose, it is especially necessary to know the polar fraction. A simple criterion for an optimal adhesion is a complete compatibility from an energetic point of view as well as the presence of a polar fraction, which is as large as possible, on both sides. It follows that the total surface energies - the dispersive as well as particularly also the polar fractions of the two phases - should be identical in order to achieve a complete wetting of the oil. For a non-stickiness, a surface energy which is as low as possible is required, together with a small polar fraction.

Reference Numbers

Disc	1
disc	2
stack of discs	3
openings	4
rising duct	5
gap	6
surfaces	7,8
coating	9,10